ARIZONA DEPARTMENT OF COMMERCE

Jeff McCormick
Regional Manager

Low Impact Development

A Brief Overview of Features & Benefits

What Is Low Impact Development?

- Land planning and engineering design that implements small scale features to protect water quality and preserve the natural hydrology of the land. Combined, LID features closely mimic pre-development hydrology.
- LID is an effective stormwater management approach, as it allows runoff to be controlled near its source. LID reduces runoff, recharges groundwater sources, and minimizes on-site dependence on stormwater systems.

Highlights / Summary

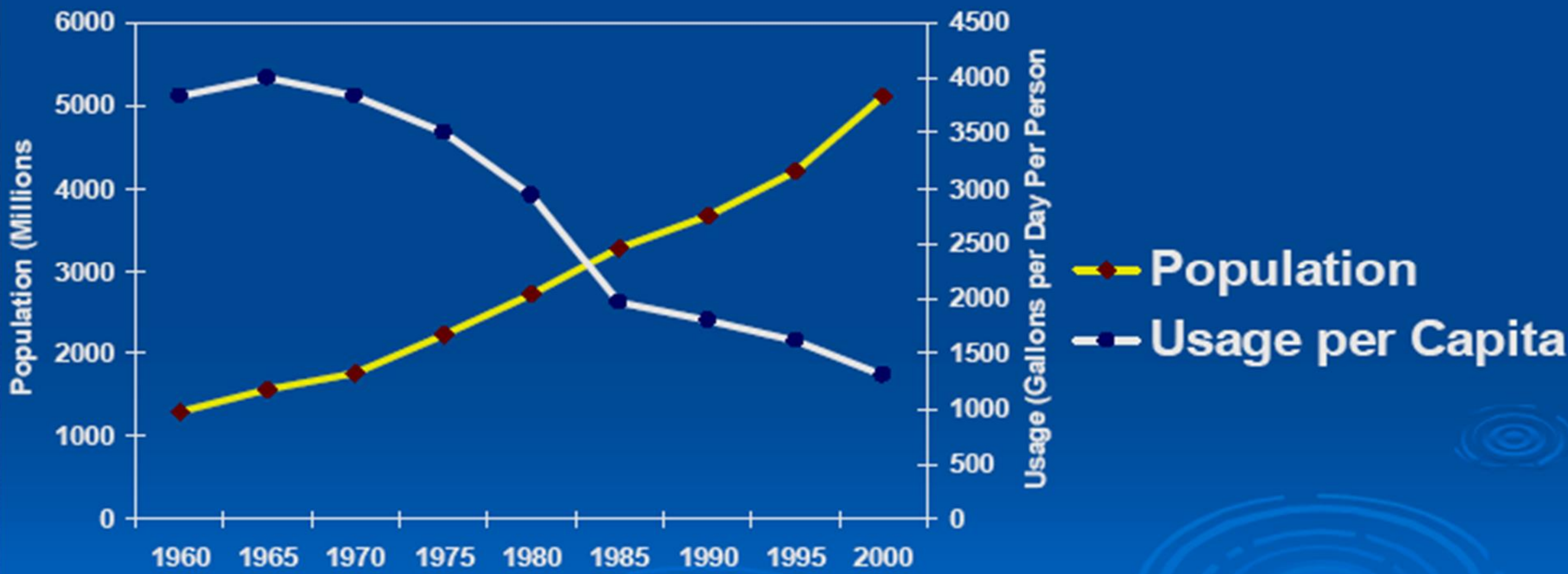
- Water: Arizona’s Precious Resource
- Land Before and After Development
- Soil Analysis and Site Selection
- Three Major Features of LID
- LID: An Alternative to Stormwater
- An Economic Analysis of LID

Arizona Water Supply

- Arizona demand: Approx. 7 million acre-feet annually (One ac-ft = 325,850 gal.)
- Demand projected to increase 25% by 2020
- 40% supplied by groundwater pumping
- 40% supplied by Colorado & Gila Rivers
- 15% supplied by surface water sources

Source: Arizona State University & Salt River Project

Arizona water usage – historical



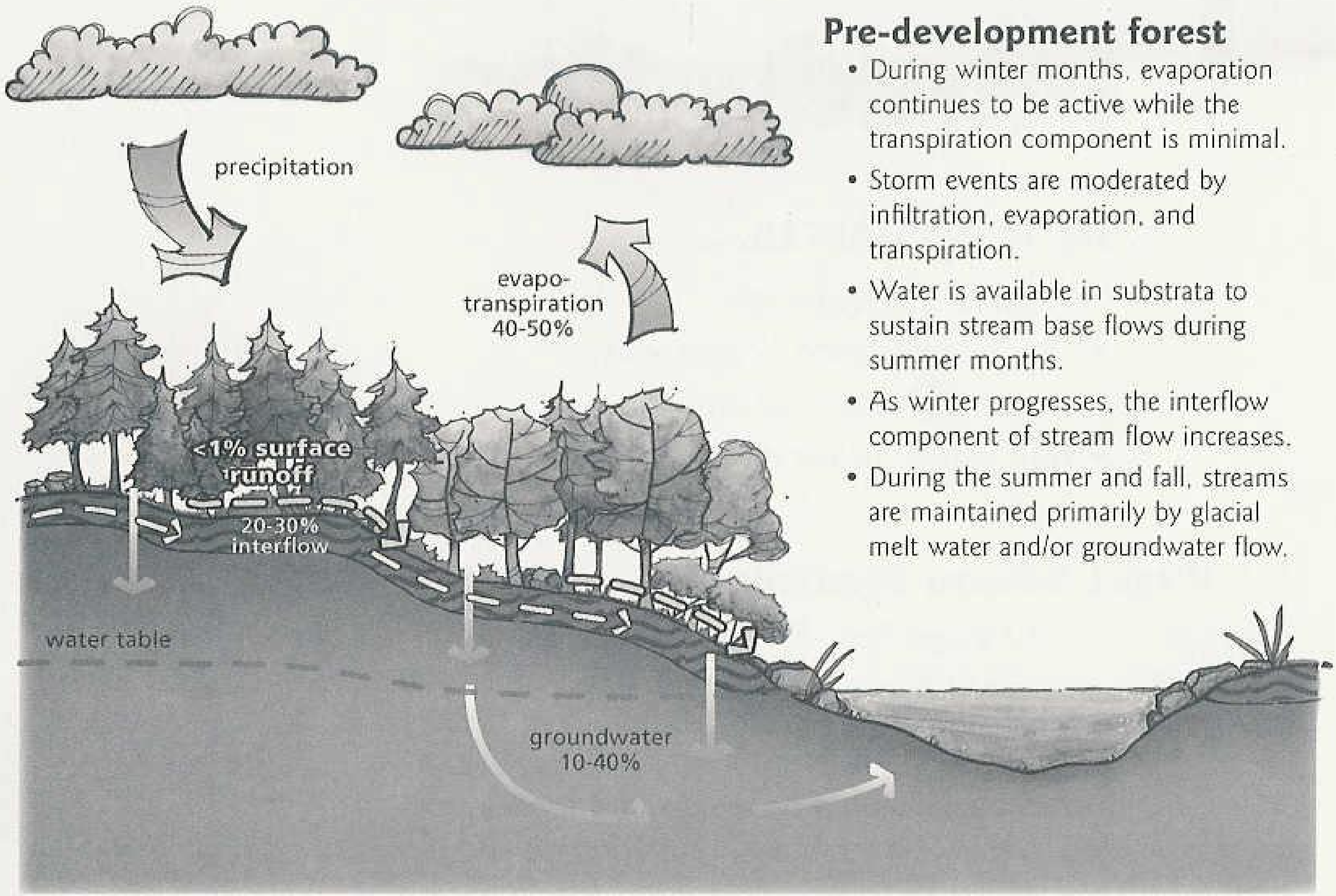
Source: Arizona Public Service

LID Recharges Aquifers

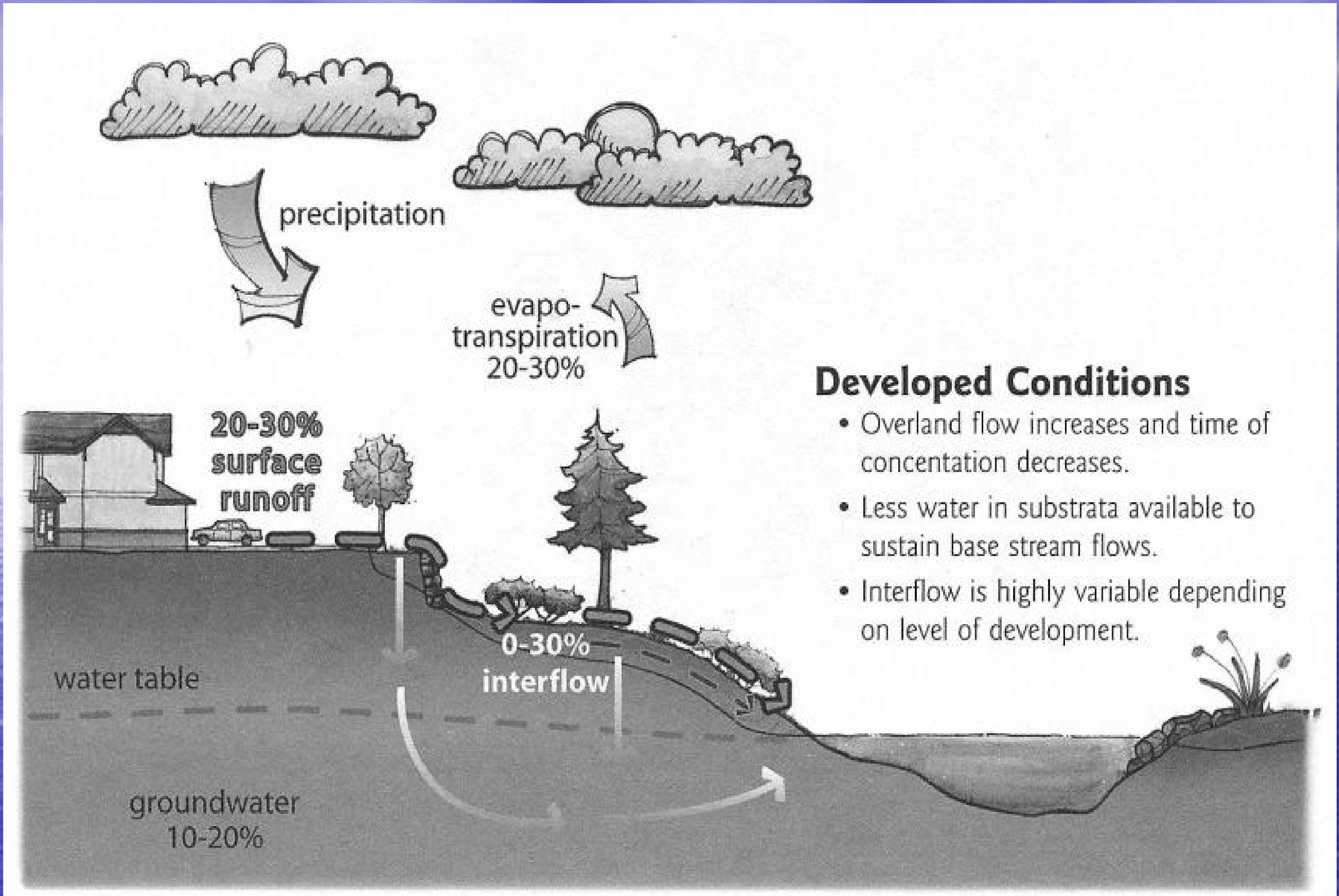
- Most aquifers in Arizona are consolidated aquifers where water is stored in rock fractures and caverns
- Monsoon rains don’t recharge aquifers because the rainfall duration is too short and run off too fast – Impervious surfaces compound the run off problem
- Steady rains and snowfall allow some recharge
- Water in aquifers is thousands of years old – The last major recharge of groundwater sources occurred during the Ice Age 10,000 years ago
- LID controls run off near its source and allows water to infiltrate the soil and descend to the water table

Pre-development forest

- During winter months, evaporation continues to be active while the transpiration component is minimal.
- Storm events are moderated by infiltration, evaporation, and transpiration.
- Water is available in substrata to sustain stream base flows during summer months.
- As winter progresses, the interflow component of stream flow increases.
- During the summer and fall, streams are maintained primarily by glacial melt water and/or groundwater flow.



Source: Puget Sound Partnership



Source: Puget Sound Partnership

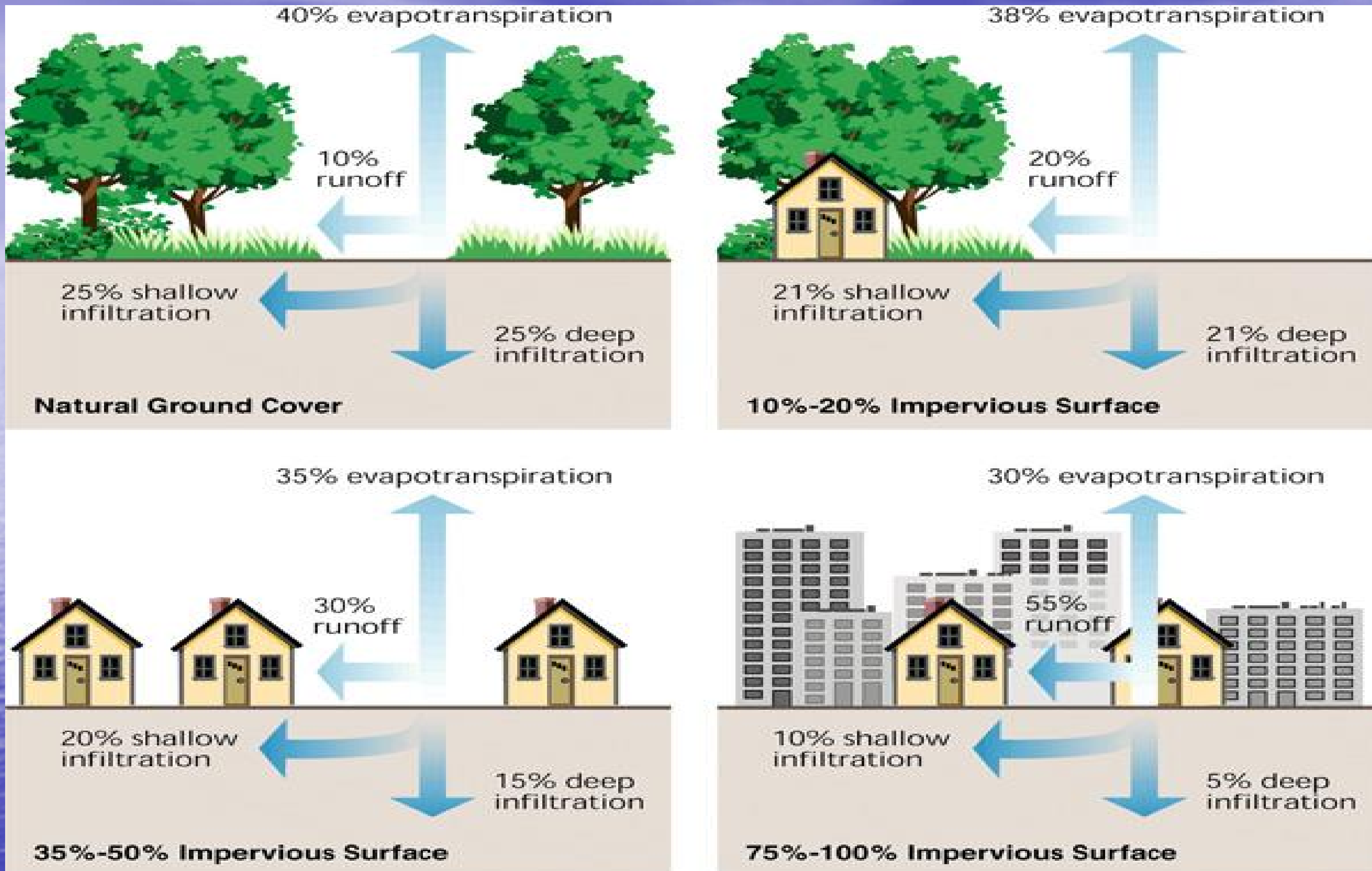


Fig. 3.21 -- Relationship between impervious cover and surface runoff. Impervious cover in a watershed results in increased surface runoff. As little as 10 percent impervious cover in a watershed can result in stream degradation.
In Stream Corridor Restoration: Principles, Processes, and Practices (10/98).
By the Federal Interagency Stream Restoration Working Group (FISRWG) (15 Federal agencies of the U.S.)

Source: Federal Interagency Stream Restoration Working Group, 15 Federal Agencies

LID Features

- Closely mimics pre-development hydrology
- Recharges groundwater sources – 40% of supply – rather than surface water
- Pervious surfaces allow water to penetrate material and infiltrate sub-surface soil
- Rainwater Harvesting (catch and store)
- Bioretention cells minimize requirements for stormwater/curbside gutters to direct runoff

Site Selection

- Soils that readily infiltrate water are best
- Soils that support septic tanks are good
- Stable soils required for development
- Avoid sites near surface water/wetlands
- Sites with deeper water tables preferred
- Sites with gentle slopes preferred
- Combined features of LID proven an effective runoff-reduction/flood-control approach
- Proven capability mitigating major storm events; stormwater's limited capacity restricts capability

Pervious Surfaces

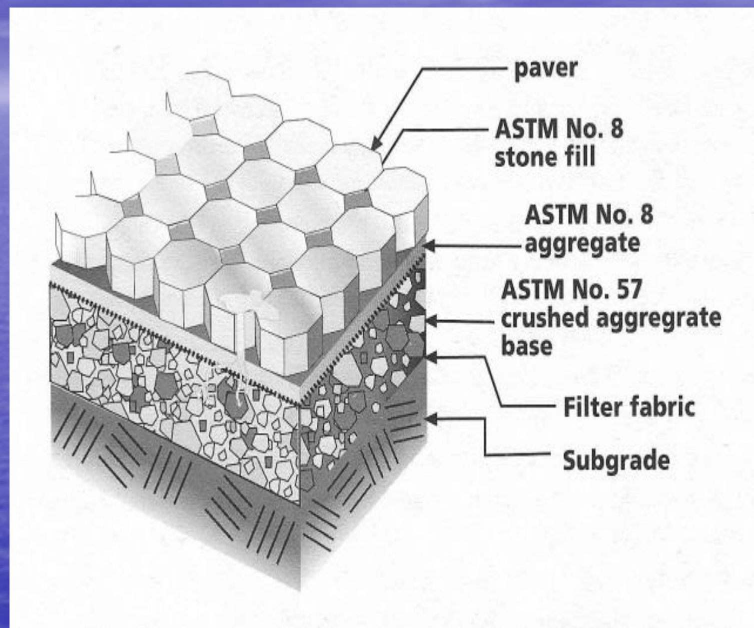
Pervious Pavement

- Allows 4-8 gallons/minute to pass through each square foot of pervious material; facilitates infiltration into soil
- Pollutants, sediment and vehicle drippings filtered by geological material before reaching water table
- Compression, shrinkage, weight-bearing, cold-heat tolerances, long-term durability all comparable
- Pervious surfaces not often used for high traffic roads, though less water results in less spray and splash
- Good for residential roads, alleys, driveways, sidewalks, bike paths, most parking lots and low traffic roads


Asphalt
Pervious Concrete

Pervious Pavement

- Larger aggregate creates larger void space
- 15-25% void space allows water to penetrate
- Minimal sand content creates added void space
- Rounded aggregate minimizes surface roughness
- Cost of material higher, less cost to install; offset by savings in minimizing stormwater requirements, detention/retention basins
- Additional thickness and deeper sub-grade
- Modifications can prevent “frost heave” damage
- Air flow in void space can improve cold-heat tolerances, mitigate heat island effect, increase long-term life cycle


paver
ASTM No. 8
stone fill
ASTM No. 8
aggregate
ASTM No. 57
crushed aggregate
base
Filter fabric
Subgrade

Pervious Pavement

- 90% of surface pollutants are carried by the first 1-1.5 inches of rainfall
- Run off contains high concentrations of sediment, heavy metals, and hydrocarbons (vehicle drippings)
- 90% of hydrocarbons in run off come from binder and sealer agents in asphalt
- Pervious concrete captures 96% petroleum; regular concrete 70%; asphalt 50%
- Deeper sub-grade allows pavement to hold more water until absorbed into soils
- Best management practice for clay-based soils

Source: Environmental Protection Agency

Pollutant Removal Efficiencies for Various Pavement Types

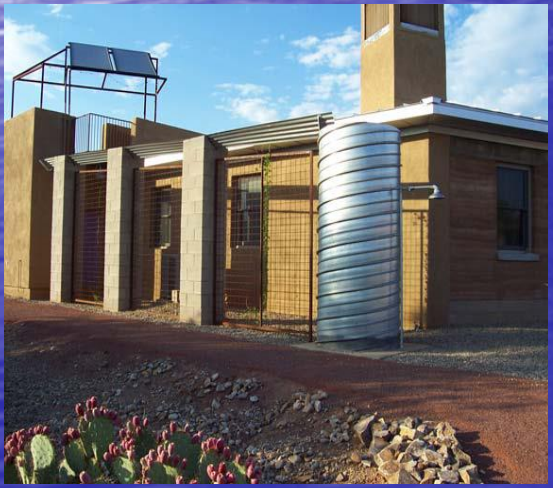
	Percent pollutant reduction compared to asphalt non-swaled		
	Asphalt with Swale	Cement with Swale	Permeable with Swale
Ammonia	45	73	85
Nitrate	44	41	66
Total Nitrogen	9	16	42
Ortho Phosphorus*	-180	-180	-74
Total Phosphorus*	-94	-62	3
Suspended Solids	46	78	91
Manganese	40	68	92
Copper	23	72	81
Iron	52	84	92
Lead	59	78	85
Zinc	46	62	75

*The efficiencies for phosphorus are negative, indicating an increase in phosphorus loads in the swaled basins. The permeable swale exhibits the best performance. Researchers believe that grass clippings leftover from swale maintenance are the likely source of phosphorus since there is no phosphorus in rainfall or asphalt and very little in automobile products.

Source: Southwest Florida Water Management District, Brooksville, Florida

Rainwater Harvesting



Rainwater Harvesting

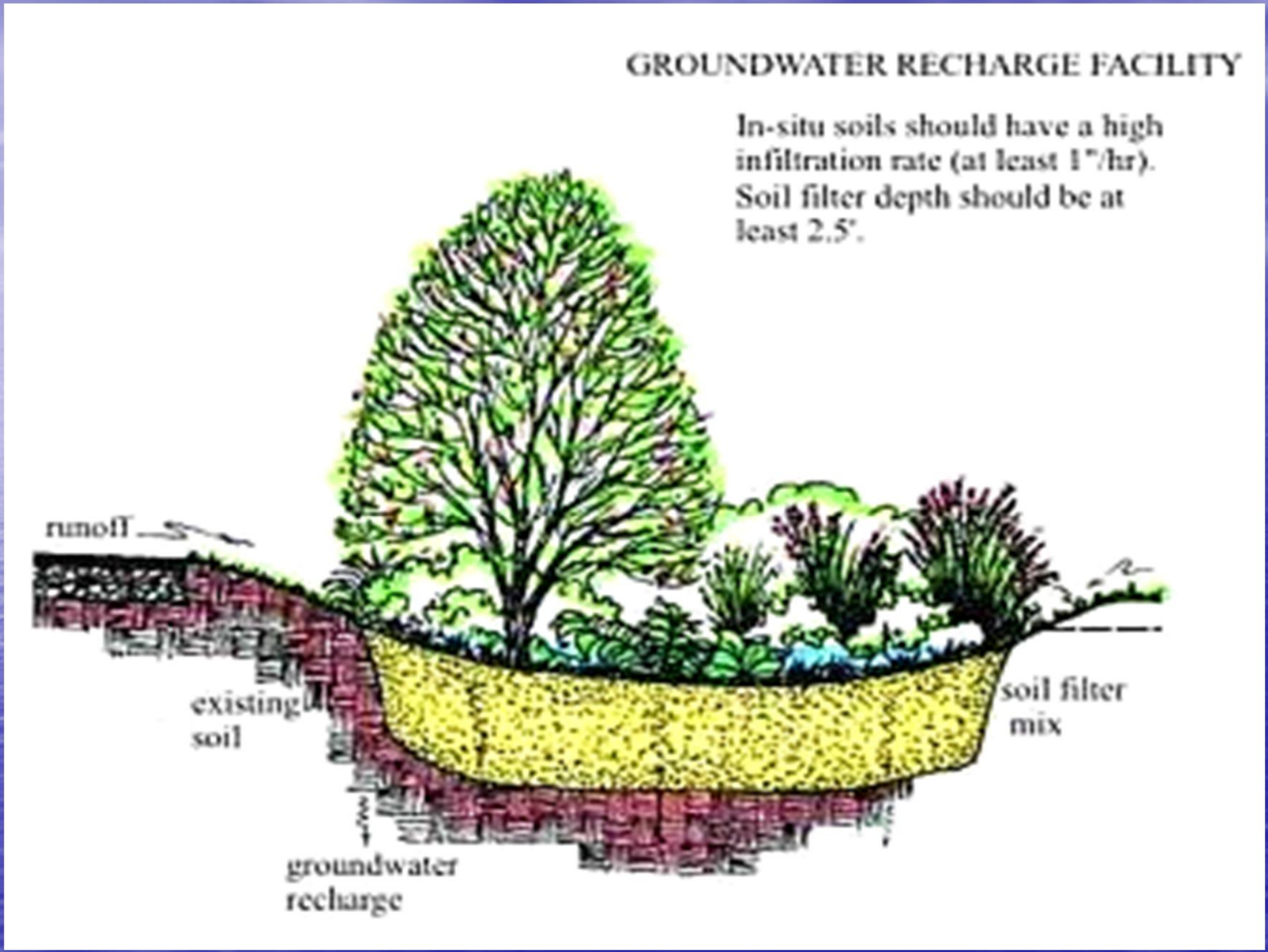
- Water drains from roof into storage barrels/tanks, then can be used for:
- Landscaping/irrigation ~50%
- Toilets ~20%
- Laundry ~10%
- Bathing/faucets ~10%
- Potable if properly filtered

Bioretention Cells / Swales




Bioretention Features

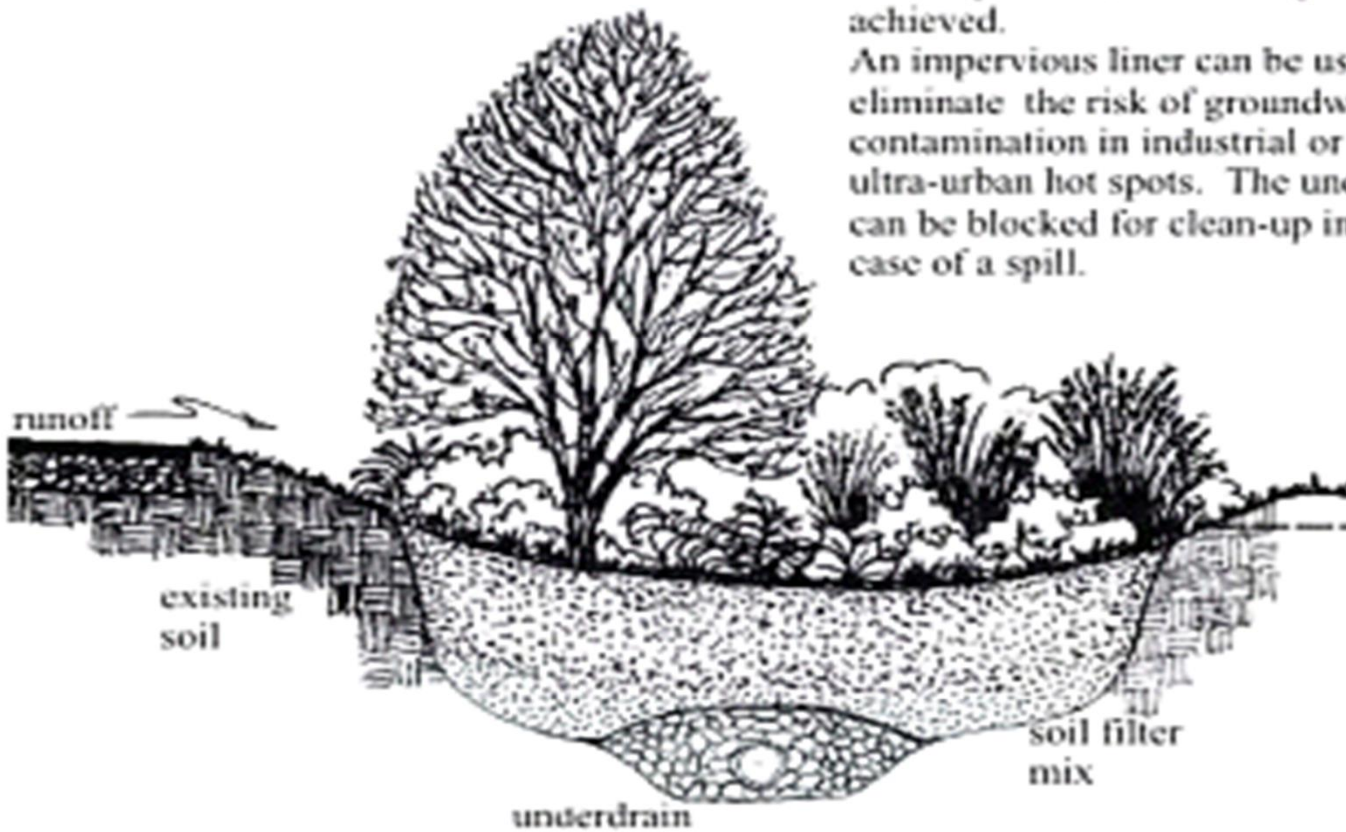
- Water directed to “rain gardens” - Typically located adjacent to roads, paths, parking surfaces - Substitute for curbside gutters
- Compost/nutrients expedite removal of biological contaminants as water infiltrates
- Filtration provided by microbes, surface soils, vegetation, plant roots and sub-surface soils
- Plants native to the region most often used
- Bioretention describes continued presence of compost/nutrients/microbes, regardless of water flow rates and duration



Source: Low Impact Development Center

HIGH FILTRATION FACILITY

The use of an underdrain ensures that the facility will drain at the desired rate.
Partial groundwater recharge is also achieved.
An impervious liner can be used to eliminate the risk of groundwater contamination in industrial or ultra-urban hot spots. The underdrain can be blocked for clean-up in the case of a spill.



Source: Low Impact Development Center

Pollutant Removal Capability

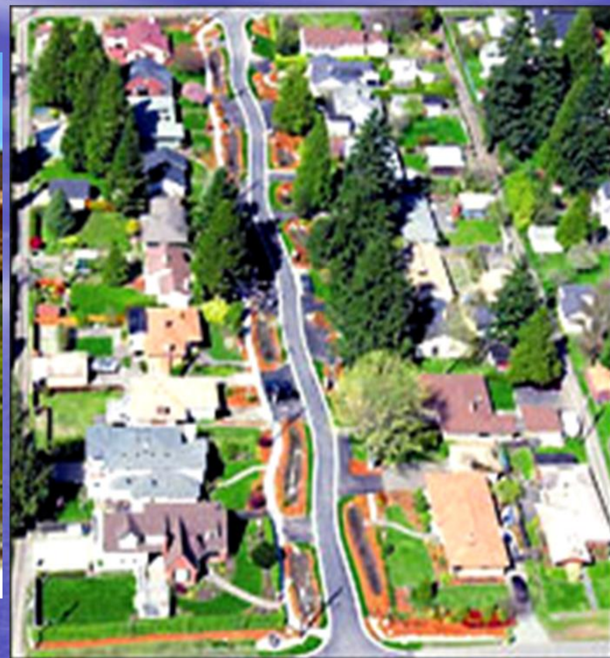
- Metals (Cu, Fe, Pb) 93-98%
- Phosphorus 70-80%
- Kjeldahl Nitrogen 60-70%
- Nitrate 20 to -194%
- Suspended Solids 90%
- Hydrocarbons 95+%
- Organics 90%

Source: Davis et al. 1998 and Hong et al. 2002


6. 20. 2002

Water-Quality Parameter	Infiltration BMP				
	Trench	Trench	Porous Paving	Porous Paving	Average Removal Efficiency
Suspended Solids	90%	---	95%	89%	91%
Phosphorus	60%	68%	71%	65%	66%
Nitrogen	60%	---	---	83%	72%
Organic Carbon	90%	---	---	82%	86%
Lead	---	---	50%	98%	74%
Zinc	---	---	62%	99%	81%
Kjeldahl Nitrogen	---	53%	---	---	53%
Bacteria	90%	---	---	---	90%
Cadmium	---	---	33%	---	33%
Copper	---	---	42%	---	42%
Metals	90%	---	---	---	90%
Ammonia	---	81%	---	---	81%
Nitrate	---	27%	---	---	27%

Source: Michele C. Adams, Stormwater, 2003



Civano: LID in Arizona

- 820 acre Master Planned Development in SE Tucson
- 2200 homes, density 1 du/ac to 35 du/ac
- 35% zoned open space
- 285,000 sf retail space
- 675,000 sf light industrial
- 65 acre environmental technology business center
- K-8 community school
- Hospital zoned, not yet built
- 1500 on-site jobs planned

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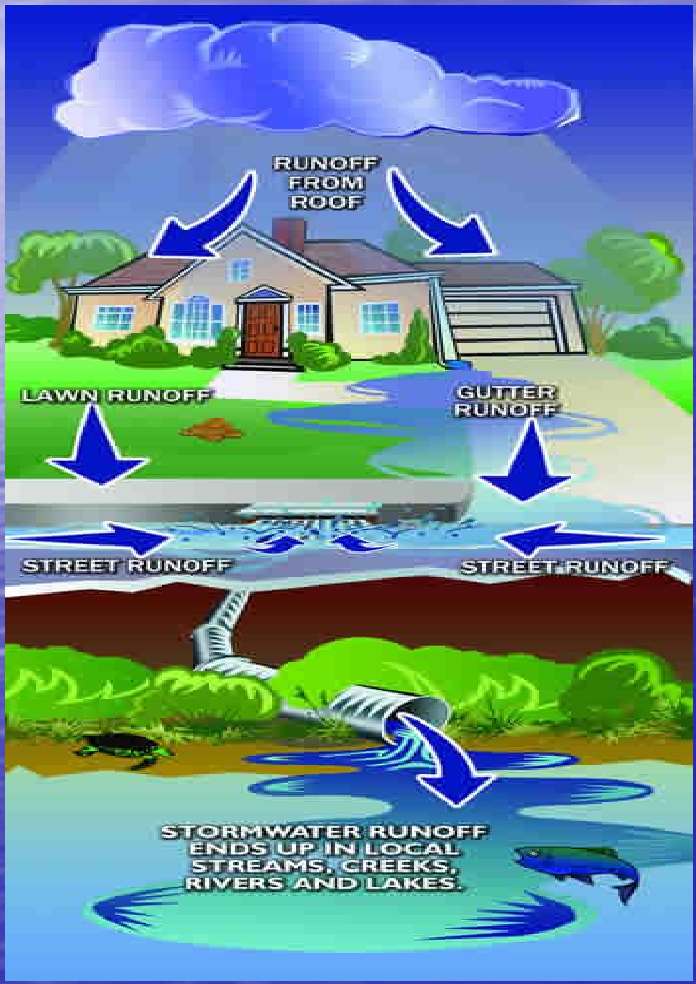
Typical Stormwater Systems



- Rainwater runs off impervious surfaces to nearest stormdrain
- Stormwater system carries water to nearby surface water
- Water treatment plant averted, as a rule; limited capacity
- Very little infiltration into soils
- Very little filtration of pollutants
- Ineffective for flood control
- Expensive to install/maintain

LID vs. Conventional Stormwater

- Nearly $3 billion needed to renovate and augment Arizona stormwater infrastructure in next 25 years (Arizona Investment Council, 2008)
- LID can cost less than conventional stormwater; fewer pipes and less below-ground infrastructure
- LID virtually maintenance-free
- LID can yield longer life cycle
- LID can reduce impact fees
- LID can increase lot yields
- LID can increase lot values
- Native vegetation and less land disturbance enhances property’s aesthetics and conserves natural features

Project	Conventional Development Cost	LID Cost	Cost Difference	Percent Difference
Mill Creek (1500 ac. cost / lot)	$12,510	$9,099	$3,411	27%
2nd Avenue SEA Street	$868,803	$651,548	$217,255	25%
Bellingham City Hall	$27,600	$5,600	$22,000	80%
Bellingham Donovan Park	$52,800	$12,800	$40,000	76%
Kensington Estates (24 ac.)	$765,700	$1,502,900	-$737,200	-96%
Tellabs Corporate Campus	$3,162,160	$2,700,650	$461,510	15%
Gap Creek (103 ac.)	**$4,620,600**	**$3,942,100**	**$678,500**	**15%**
Auburn Hills (85 ac.)	$2,360,385	$1,598,989	$761,396	32%
Somerset (80 ac.)	$2,456,843	$1,671,461	$785,382	32%
Prairie Glen (39 ac.)	$1,004,848	$599,536	$405,312	40%
Laurel Springs (42 ac.)	$1,654,021	$1,149,552	$504,469	30%
Garden Valley (9.75 ac.)	$324,400	$260,700	$63,700	20%

Source: Environmental Protection Agency

Economic and Other Benefits From Low Impact Development	
Higher Lot Yield	17 additional lots
Higher Lot Value	$3,000 more per lot over competition
Lower Cost Per Lot	$4,800 less cost per lot
Enhanced Marketability	80 percent of lots sold in first year
Added Amenities	23.5 acres of green-space/parks
Recognition	National, state, and professional groups
Total Economic Benefit	More than $2,200,000 added to profit

Source: Tyne & Associates, North Little Rock, Arkansas; Gap Creek Subdivision, Sherwood, Arkansas

Additional Information

- http://www.concreteresources.net/cd/
- http://www.perviouspavement.org/
- http://www.stormcon.com/sw_0305_porous.html
- http://www.psp.wa.gov/downloads/LID/LID_manual2005.pdf
- http://www.lowimpactdevelopment.org/publications.htm
- http://www.nrdc.org/water/pollution/storm/chap12.asp
- http://www.pierce.wsu.edu/Water_Quality/LID/index.htm

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Thank you for the opportunity to share this information with you today